

CLAIMS

What is claimed is:

1. A method of forming a multilayer dielectric film on a substrate, comprising the steps of:

5 forming a metal silicate layer on the surface of the substrate; and
forming a metal oxide layer atop the metal silicate layer.

2. The method of claim 1, further comprising:
forming another metal silicate layer atop the metal oxide layer.

3. The method of claim 1 or 2 wherein said forming steps are carried out by any
10 one of, or combination of, chemical vapor deposition (CVD), physical vapor deposition (PVD), atomic layer deposition (ALD), aerosol pyrolysis, spray coating or spin-on-coating.

4. The method of claim 1 or 2 wherein said forming steps are carried out by
chemical vapor deposition (CVD) and using an oxygen source selected from the group
consisting of O₂, O₃, NO, N₂O, H₂O, OH⁻, alcohol, alkoxides, and H₂O₂.

15 5. The method of claim 1 or 2 wherein said metal oxide layer has a dielectric
constant κ ; and said metal silicate layer has a dielectric constant lower than the dielectric
constant of said metal oxide layer.

20 6. The method of claim 5 wherein said metal oxide layer has a dielectric constant
in a range of 15 to 200 and said metal silicate layer has a dielectric constant in a range of 5 to
100.

25 7. The method of claim 5 wherein said metal oxide has the formula of M_xO_y,
where M is a metal selected from the group consisting of Zr, Hf, Ti, V, Nb, Ta, Cr, Mo, W,
Mn, Zn, Al, Ga, In, Ge, Sr, Pb, Sb, Bi, Sc, Y, La, Be, Mg, Ca, Sr, Ba, Th, Lanthanides (Ce,
Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu), and mixtures thereof, x is a number in the
range of 1 to 3, and y is a number in the range of 2 to 5.

8. The method of claim 7 wherein said metal oxide includes more than one metal element.

9. The method of claim 5 wherein said metal oxide is selected from the group consisting of ZrO_2 and HfO_2 .

5 10. The method of claim 5 wherein said metal silicate has the formula of M_xSiO_y , where M is a metal selected from the group consisting of Zr, Hf, Ti, V, Nb, Ta, Cr, Mo, W, Mn, Zn, Al, Ga, In, Ge, Sr, Pb, Sb, Bi, Sc, Y, La, Be, Mg, Ca, Sr, Ba, Th, Lanthanides (Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu), and mixtures thereof, x is a number in the range of 1 to 3, and y is a number in the range of 2 to 5.

10 11. The method of claim 10 wherein said metal silicate includes more than one metal element.

12. The method of claim 10 wherein said metal silicate is selected from the group consisting of Zr-Si-O and Hf-Si-O.

15 13. The method of claim 1 or 2 wherein said metal silicate layer has a thickness smaller than a thickness of said metal oxide.

14. The method of claim 13 wherein said metal oxide layer has a thickness in a range of about 30 to 80\AA .

15. The method of claim 13 wherein said second metal silicate layer has a thickness of one to two atomic layers.

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